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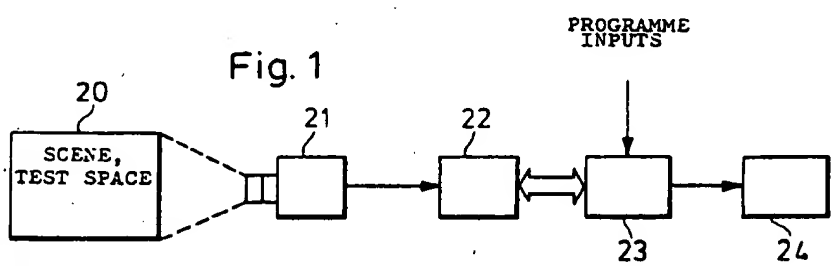
(71) Applicant
Messerschmitt-Bölkow-Blohm Gesellschaft Mit Beschrankter Haftung
Postfach 80 11 09
D-8000 Munich 80
Federal Republic of Germany
(72) and (74) continued overleaf

(54) A method of automatically ascertaining and evaluating changes in the contents of pictures, and arrangement therefor

(57) A method of ascertaining the contents of pictures derived from a location 20 being monitored (e.g. changes of positions of fish in water, or traffic in traffic flow, or targets moving over terrain) and determining differences between the contents of pictures occurring at intervals of time to permit evaluation thereof comprises recording the scene unit a TV or IR camera 21, scanning the recorded picture in lines, point-by-point and deriving therefrom, and a standard video signal, a video signal for evaluation, and subtracting successive said video signals point-by-point, the one from the other so as to determine the number of anti-coincidences which gives a measure of the change in picture content occurring in the period of time between the said successive signals. A preferred analyser for carrying the method into effect comprises the camera 21, a signal processor 22, a computer/control unit 23 having provision for control or programe inputs, and a registering unit 24.

Fig. 1



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(72) Inventors
Karl Dzida
Peter Scholler
(74) Agents
Barlow Gillett & Percival

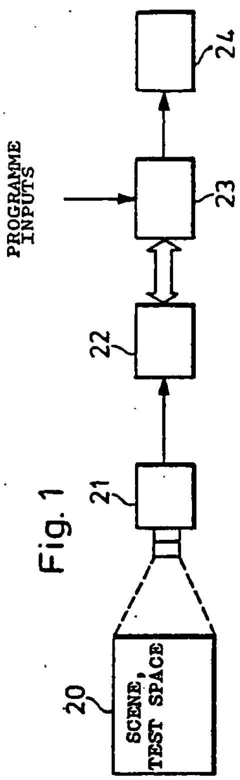
PROGRAMME INPUTS
SCENE, TEST SPACE
20
21
22
23
24

Fig. 1

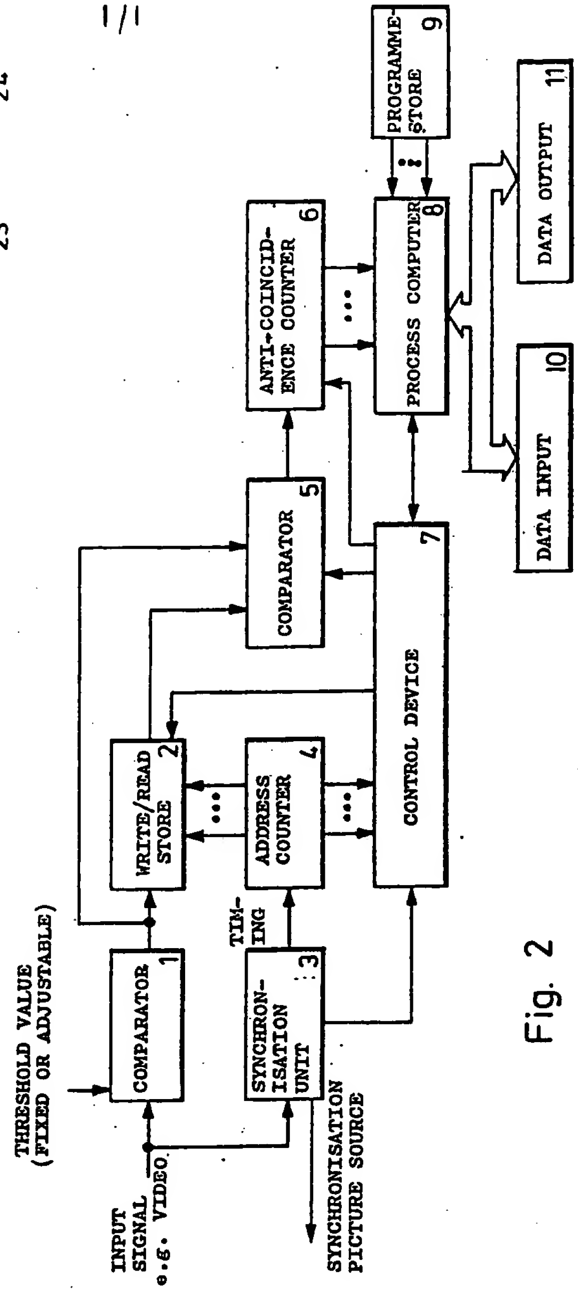
THRESHOLD VALUE (FIXED OR ADJUSTABLE)
INPUT SIGNAL e.g. VIDEO
COMPARATOR 1
WRITE/READ STORE 2
SYNCHRONISATION UNIT 3
TIMING
SYNCHRONISATION PICTURE SOURCE
ADDRESS COUNTER 4
COMPARATOR 5
ANTI-COINCIDENCE COUNTER 6
CONTROL DEVICE 7
PROCESS COMPUTER 8
PROGRAMME STORE 9
DATA INPUT 10
DATA OUTPUT 11

Fig. 2

SPECIFICATION

A method of automatically ascertaining and evaluating changes in the contents of pictures, and an arrangement therefor

The invention relates to a method of automatically ascertaining and evaluating (or interpreting) changes in the contents of pictures, for example for monitoring the movement activity of experimental animals and a movement analyser for carrying out the method.

Because of increasing environmental pollution, ever greater importance is attached to ascertaining the harmful concentrations of toxic substances. In this connection, for example when monitoring the quality of water, of the many toxic components which may be present can no longer be evaluated in their entirety by chemical analyses. Therefore, to determine the biocidic action of substances present in use can be made only of test organisms which display characteristic symptoms in the presence of both known and unknown harmful substances (see, on this score, the Supplement to "Bild der Wissenschaft", issue No. 8, August 1973, page 4). This indirect measuring method is thus based on monitoring the behaviour of organisms and also, perhaps, fish such as trout or golden orfes, and nowadays is used only to a small extent employing experts as observers; in this respect, on account of high staff costs, the monitoring cannot be carried out continuously. In recent years automatically-operating measuring systems have been increasingly favoured when monitoring harmful substances, which systems have the advantage of objective measurement without human fatigue phenomena expecially with short prewarning times. In addition, these systems lead to considerable savings in costs.

The automatic methods for motility measurement which have so far become known are restricted to water organisms and can be split up into non-contact and contact methods.

Non-contact methods:

a) *Optical methods:*

The organisms to be studied can move freely in a test basin. When swimming through a light barrier, a pulse is registered. This method is mainly applied in research. The expenditure involved in the overall monitoring of a basin is, of course, technically practicable only if use is made of a multiple-barrier system, and even is then the apparatus involved is very expensive. Maintenance-free operation over fairly long periods of time is not possible, since the optical system varies in sensitivity as a result of vegetation growth and water turbidity. Added to this is the fact that the behaviour of the fish is influenced by the light beams which are generally bunched very closely together (see also German Offenlegungsschrift No. 23 04 315).

b) *Electrical methods:*

Electrical methods have, as their basis, the fact that the test organisms influence an electrical field, either actively e.g. by implanted magnets or metal foreign bodies, or passively. The field change is measurable. The active method has the disadvantage that the fish are disturbed in their behaviour by the implant. This disturbance may be slight, it is true, but nevertheless it is measurable. On the other hand, the method would seem to be ruled out unless trained experts undertake the implantation. Passive methods, in which the fish influences the electrical field between feed electrodes, can be used to a limited extent, as continuous methods, in cases where severe changes in physical parameters in the water occur. Furthermore, then, electrical stimulation of the fish cannot be completely precluded (see also German Auslegeschrift No. 23 62 084).

c) *Acoustic methods:*

Acoustic methods for motility measurement of water organisms have greater advantages than the methods already mentioned since they are very insensitive to water pollution and in frequency ranges above about 20 kHz do not influence the behaviour of the fish. Fish-testing apparatus which ascertains the movement activity by varying a stationary sound field is known. This apparatus is very sensitive and does not allow adequate filtering of ambient background noise. Use in flowing water is practically not possible.

A further known form of acoustic fish testing apparatus ascertains the swimming movement of the test organisms when passing barriers (see on this score the apparatus available under the designation AQUMEX from Messrs. Farad of Stockholm). The monitoring of a relatively large test volume which is nowadays necessary is, however, realisable only with disproportionate expenditure.

Contact methods:

All these methods are based on the fact that a pulse is triggered as a result of contact of a mechanical or pneumatic- electrical measuring system by the test fish a pulse is triggered. This signal can then be fed to an appropriate evaluating or logic device by which it can be processed for warning and monitoring purposes. At least in the case of flowing water these methods have the disadvantage that flow resistance of the test system is increased and signals are triggered prematurely as a result of vegetation growth (see also German Offenlegungsschrift No. 2 164 702).

The problem of the invention is to provide a method (and an apparatus therefor) of the kind mentioned at the introduction hereof,

which is suitable for use in those regions of technology in which picture content changes have interpretation significance whereby experimental animal tests and perhaps also fish tests as provided for within the framework of the law on waste water output, or motility tests on test organisms can be effected in a fully-automatic manner without human intervention and so as to achieve the best possible results.

This problem is solved in that the scene to be monitored is recorded by means of a recording unit such as a television camera or IR camera, in that the recorded picture is scanned in lines point-by-point, in that from this and by means of sync pulses for line and picture changes, a standardised video signal is provided, in fact each pair of these video signals issued at predeterminable time intervals Δt, are subtracted from one another point-by-point and in that the number of anticoincidences is ascertained as a measure of the picture content change during the time interval Δt.

Further developments of the method and a movement analyser for carrying the method into effect are apparent from the sub-claims.

The advantages of the invention lie primarily in the fact that a non-contact measurement which does not influence the experiment events is involved. The method and the apparatus therefor are suitable for the most varied test organisms without dependence on the dimensions of the test space. Both still and flowing media can be evaluated.

The wide flexibility of the method, which in the final analysis also affects the cost question, in addition permits its use in many other spheres of technology in which change of the contents of a picture has interpretation significance, for example in traffic for ascertaining the traffic flow or in army technology for monitoring an area of terrain or the tracking of moving targets.

The invention will be described further, by way of example, with reference to the accompanying drawing in which:–

Figure 1 is a block diagram illustrating a preferred embodiment of the movement analyser of the invention; and

Figure 2 is a block circuit diagram of the said analyser.

As shown in Fig. 1, a scene 20 is monitored by a recording unit 21, such as a television camera or infra-red camera. A worked-up signal (see in more detail Fig. 2) therefrom passes to a signal processer 22, which is coupled with a computer/control unit 23. Here any desired predetermined parameters can be introduced. Finally the desired data is kept ready in a registering unit 24 for subsequent use.

As shown in Fig. 2, the movement analyser comprises a comparator 1, a synchronisation unit 3, a write/read store 2 with an address counter 4, a further comparator 5, an anti-coincidence counter 6 as well as a control device 7 and a process computer or calculator 8 with an associated programme store 9 and a connected data input 10 and data output 11.

In the analyser, an input signal, which derives from any desired picture signal source, is converted with the aid of the comparator 1 into a binary signal and is fed to the store 2. The write-in rhythm is produced in the synchronisation unit 3 and synchronised with the input signal, so that each line is split up into, for example, 128 picture points or dots. The address counter 4 determines the storage places in which the respective picture content is stored. The comparator 1 can compare grey stages for each picture point. The decision of the comparator can also be a light/dark decision, in which case the switching threshold is either fixedly set or is adjusted in accordance with picture brightness. In this respect, a good contrast must exist between any moving object and the background, a favourable threshold value corresponding to a certain extent to the mean picture brightness. The store requirement then amounts, for example for a complete television picture (or half picture, line jump) to $128 . 128 = 2^{14}$ 16 K.

Moreover, the synchronisation unit 3 produces reference signals for the control unit 7, for example the synchronised picture scan signal, recognition of the 1st or 2nd half picture or line synchronisation. The control device 7 clears the counters 4 and 6 in synchronism with the scanning of the picture and determines whether a new half picture, (which is always either the 1st or the 2nd half) is read into the store 2, or whether the previous, or old, half picture remains read-out or stored.

Reading-out is effected in synchronism with the scanning of the incoming picture signal, so that the old picture can be checked for variation with a new "on line", picture i.e. directly in the comparator 5, for example Exclusive-OR. The picture changes which have occurred are ascertained in the anti-coincidence counter 6 and transferred to the process computer 8, which may, for example, be a microprocessor. The processor computing process is fixed in the exchangeable programme store 9. Initiation and input of parameters or also new programmes is effected by way of a data input 10, using for example a keyboard, a switch or switches or a punched-strip reader. The evaluated results appear at the data output 11, which is, for example, a printer, a writer, or an alarm issuer.

The counter state of the anti-coincidence counter 6 is a measure of the change in the picture content of two pictures which follow one another at a predetermined time interval Δt. If this comparison is effected constantly,

then the computer ascertains continuously a standard for (or measure of) movement in the picture being considered. The ascertained function can be smoothed (or equalised) for example in accordance with suitable algorithms, and evaluated in accordance with the appropriate applicability. Picture sections can be extracted; also the following of a moving object is possible.

CLAIMS

1. A method of automatically ascertaining and evaluating changes in the contents of pictures, for example for monitoring the movement activity of experimental animals, characterised in that the scene to be monitored is recorded by a recording unit such as a television camera or IR camera, in that the recorded picture is scanned in lines point by point, in that from this and by means of sync pulses for line and picture change, a standardised video signal is provided, in that each pair of video signals issued at a predetermined time interval (Δt) are subtracted from one another point-by-point and in that the number of anti-coincidences is ascertained as a measure of the change in picture content during the time interval (Δt).

2. A method as claimed in claim 1, characterised in that a problem-related programmable computer serves, after the comparison, to evaluate the comparison state according to presettable criteria and in that the result is stored in a register unit.

3. A method as claimed in claim 1 or 2, characterised in that an alarm is triggered when presettable limiting values of the extent of the change in picture content are exceeded.

4. A method as claimed in claim 1, 2 or 3 characterised in that the evaluation is of already-recorded pictures, recorded for instance by means of video recorders, or is of pictures originating from a picture signal source.

5. A method of automatically ascertaining and evaluating changes in the contents of pictures substantially as herein described with reference to the accompanying drawing.

6. A movement analyser for carrying out the method of any of claims 1 to 5 characterised in that it comprises a recording unit, such as a television camera or IR camer, having connected thereto, successively, a signal processing arrangement, a computer/control unit and a registering unit.

7. A movement analyser as claimed in claim 6, characterised in that the signal processing arrangement has a comparator which receives a signal supplied by the recording unit and a synchronisation unit, in that the output signal of the comparator is feedable both to a write/read store and to a comparator connected to the output of the store, in that the cells of the store are selectable by way of an address counter which is connected to the synchronisation unit and a control device, in that a picture which is stored in the store and a following picture are feedable synchronously by way of the control device to the comparator, in that an anti-coincidence counter is connected subsequently to the comparator, in that the run-up counter state is evaluatable and various programmes and cycle controls are activatable by means of programme stores, by way of a process computer and in that the process computer is connected to a data input and a data output.

8. A movement analyser as claimed in claim 7, characterised in that a threshold value which corresponds to the mean picture brightness is feedable to the comparator and in that, as a function of the threshold value being dropped below or exceeded, a decision can be made on white <log. 0> or black <log. 1> respectively.

9. A movement analyser substantially as hereinbefore described with reference to and as illustrated in the accompanying drawing.

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